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BRIEF COMMUNICATION

CAUSES OF RARITY IN *ABUTILON OXYCARPUM* AND *HIBISCUS BRACHYSIPHONIUS* (MALVACEAE) ON THE RIVER MURRAY FLOODPLAIN, SOUTH-EASTERN AUSTRALIA

A central problem in deciding conservation priorities for plant species in arid and semi-arid areas is that some species appear briefly following particular environmental triggers and then disappear for years until the trigger recurs. Such transient species[1] are often listed as rare but are not necessarily threatened as long as the natural cycle continues without interference. So far, work on such species in semi-arid Australia has been concentrated on post-fire pioneers[1,2]. However, many transient species are triggered by infrequent rainfall events[3]. Because their ecology and conservation are poorly understood, here we use long-term data from 1983 till 1999 to explore the issues involved, including causes of rarity and the amount of rainfall needed to trigger germination and growth.

Abutilon oxycarpum (F. Muell.) F. Muell. ex Benth. var. *malvaefolium* Benth. (Malvaceae) (Fig. 1) is a herb which may reach 8 cm and which behaves as an annual in Victoria. Data are also presented for *Hibiscus brachysiphonius* F. Muell. (Malvaceae), a subshrub to 15 cm high which resprouts from a perennial rootstock. Both species have their main growth period following rain in the warmer months of the year, in our area principally from November until April. Both taxa occur in all mainland states and at least as far north as 20° S[4].

Abutilon oxycarpum and *H. brachysiphonius* were unknown in Victoria until 1983 when they were recorded in close proximity at Bottle Bend near Red Cliffs, Vic. (Browne 1986; Fig. 2). This was in the first week of March following 32 mm of rain. For both taxa, the Victorian stands are widely disjunct from those elsewhere in Australia and represent their southern limit[5,6]. Neither taxon is threatened in Australia and frequencies greater than 50% have been recorded for them in some central Queensland communities[7]. However, in Victoria, *A. oxycarpum* is rated vulnerable and *H. brachysiphonius* endangered[8]. They will be referred to as *Abutilon* and *Hibiscus* throughout this paper.

The known Victorian range of *Abutilon* and *Hibiscus* is in an area less than three km across on grey cracking clays of the River Murray floodplain within 0.6 km of the river near Bottle Bend (Fig. 2). *Abutilon* and *Hibiscus* occur together at sites 1 and 2 and *Abutilon* occurs at sites 3 and 4. Site 4 is a depression dominated by scattered shrubs of *Muehlenbeckia florulenta* Meisn. (Tangled Lignum); all other sites contain *Eucalyptus largiflorens* F. Muell. (Black Box) woodland with a sparse understorey of occasional chenopods and *Zygophyllum* spp.

The climate is semi-arid, with a mean annual rainfall of 290 mm at Red Cliffs, the wettest months being from May to October. The rainfall is highly variable, especially in summer when rain usually occurs as heavy downpours during thunderstorms. Summers are hot and winters mild, with frosts occurring.

Site 2 was inspected in January 1991 (12 plants) and site 3 in January 1984 (4 plants). No further inspections were made due to track closures. Other sites were inspected at least annually in summer-autumn between 1983 and 1995 and again between 1997 and 1999 (Table 1). Areas of the same habitat in nearby Kings Billabong Wildlife Reserve, Lambert Island and elsewhere were searched intensively for the two taxa without success. Voucher specimens are lodged at MEL.

The plant data recorded in Table 1 refer to *Abutilon* plants less than one year old and to resprouts from perennial rootstocks of *Hibiscus*. Rainfall data are from Red Cliffs, less than 10 km away.

The first stands of both taxa seen (at site 1) were in an area where trees had been felled and soil disturbed by

Fig. 1. *Abutilon oxycarpum* 5 cm across at Bottle Bend Reserve, showing flower and fruit.

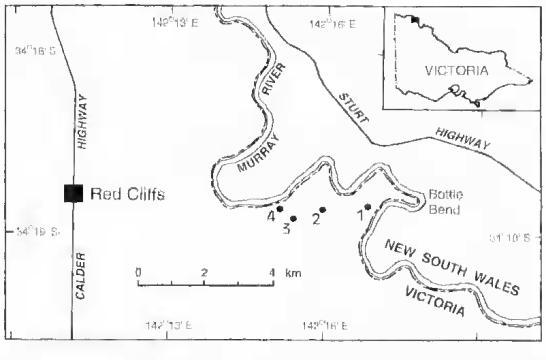

Fig. 2. Location of Bottle Bend Reserve, showing the only four sites where *Abutilon oxycarpum* has been seen in Victoria. Sites 1 and 2 also carry stands of *Hibiscus brachysiphonius*.

TABLE 1. *Monthly rainfall totals (mm), significant rainfall episodes and numbers of* Abutilon *and* Hibiscus *at site numbers 1 and 4, Bottle Bend Reserve for November to April 1982-1999.*

Year	Rainfall (mm)						Major rainfall episodes	Plant numbers			Notes on Site 4
	Nov	Dec	Jan	Feb	Mar	Apr		*Abutilon* Site 1	*Abutilon* Site 4	*Hibiscus* Site 1	
1982-83	4	1	0	1	48	10	32 mm, 2-7 Mar	50	30	8	
1983-84	23	20	49	4	14	21	28 mm, 1-3 Jan	100	47	13	
1984-85	8	0	7	0	3	6	None	0	0	0	
1985-86	38	35	0	11	0	6	26 mm, 6 Nov; 24 mm, 9 Dec	0	3	5	
1986-87	20	43	11	15	14	9	21 mm, 8 Dec	0	0	0	
1987-88	4	31	22	2	12	38	No falls above 16 mm until Apr (23 mm)	0	0	0	
1988-89	59	27	12	2	74	66	37 mm, 14 Mar	present	present	10	
1989-90	34	25	11	9	8	35	26 mm, 4-6 Nov; 26 mm, 21-23 Apr	0	0	0	
1990-91	4	9	88	0	0	23	32 mm, 7 Jan; 39 mm, 24 Jan	present	0	200+	Flood, then dense *Eleocharis*
1991-92	31	3	1	9	6	12	26 mm, 26 Nov	0	0	0	Dense *Eleocharis*
1992-93	56	94	77	10	11	0	Falls of more than 30 mm in Nov, Dec & Jan	0*	0	present	Flood, then dense *Eleocharis*
1993-94	23	62	5	95	0	3	29 mm, 22 Dec; 49 mm, 11 Feb; 27 mm, 14 Feb	0*	0	present	Dense *Eleocharis*
1994-95	15	11	54	20	0	18	19 mm, 6 Jan; 10 mm, 16 Jan; 16 mm, 30 Jan	0	0	present	Dense *Eleocharis*
1995-96							No data				
1996-97							No data				
1997-98	31	9	37	26	0	47	No falls above 17 mm	0	0	present	
1998-99	19	3	17	38	17	5	29 mm, 12 Feb	present	present	present	

* The *Abutilon* part of Site 1 flooded briefly in November 1992, resulting in a dense *Chloris* stand in 1993-94.

tractor to lay a telephone cable, suggesting pioneer-type behaviour as in some other Malvaceae[3]. However, all subsequent stands found have been in intact vegetation lacking soil disturbance.

When observations started, the area was lightly grazed by Western Grey Kangaroos and cattle: these animals readily eat both *Abutilon* and *Hibiscus* and marked grazing effects were observed.

The falls of rain tabulated usually resulted from single warm-season storms, but sometimes significant rains over two or three consecutive days are given (Table 1). Over the 15 years studied, *Abutilon* appeared in 5 years at any one site and *Hibiscus* in 10 years (Table 1). At least one episode of rain of more than about 26 mm between November and March seems to be needed for plants of both species to appear in the study area. In seasons like 1994-95 and 1997-98, a series of smaller falls than this scattered through a month is enough for *Hibiscus* but not *Abutilon* to grow (Table 1). Single falls of 26 mm (e.g. 1991-92) or less usually do not produce either species (Table 1).

Following germination in *Abutilon*, development is rapid. After the significant rainfall of 2-7 March 1983, *Abutilon* had flowers and fruit in 5 weeks and mature seed in 7.5 weeks despite little extra rain. Plants only 4 cm high can produce seed. Most *Hibiscus* plants were partly grazed off, but flower buds were produced by 2 weeks.

Of the original eight re-sprouting *Hibiscus* plants seen in 1983, all were still alive in 1989 and four were still alive in 1999, giving a minimum lifespan of 16 years. In the study area, cattle grazing was discontinued in 1988 and following 32 mm of rain on 7 January 1991, a further 200 resprouting *Hibiscus* plants were found in an area adjoining the original stand and which had been searched previously for this species. We believe that this occurred through a combination of the rainfall and the absence of cattle grazing, with the grazed-off plants being undetectable in the presence of cattle. This more recent, larger population continues to appear, given appropriate rainfall. Since 1988, it is clear that some kangaroo grazing of both taxa occurs, especially of *Abutilon* at site 4.

In the second half of 1990 the lowest site, site 4, was flooded by high river levels. It was still flooded and dominated by a dense stand of the sedge *Eleocharis acuta* R. Br. in November 1990. This almost certainly caused the

absence of *Abutilon* in 1990-91 despite suitable rainfall (Table 1).

November 1992 had the highest river levels since 1981[4], flooding site 4 again and the *Abutilon* and part of the *Hibiscus* stand at site 1. Hence dense *Eleocharis* continued to dominate site 4 until at least 1994-95, accounting for the absence of *Abutilon* in the three years 1992-95, despite suitable rain. No small plants occur within the dense stem and rhizome systems of *Eleocharis*, presumably because they are outcompeted.

At the site 1 *Abutilon* stand, higher than site 4, the flood drained away quickly. A dense stand of the grass *Chloris truncata* resulted, accounting for the absence of *Abutilon* following good rains in the two years 1993-95 (Table 1). By the time of the 1997-99 records of *Abutilon* and *Hibiscus* (Table 1), *Chloris* and *Eleocharis* had disappeared from the sites.

We conclude that the major abiotic determinants of *Abutilon* mature plant occurrence in the area are warm-season rainfall and flooding, the former necessary for recruitment and the latter temporarily excluding *Abutilon* by promoting dense stands of competing species. Assuming that an episode of rain of more than 26 mm between November and March is needed for germination, in seven of the 15 years site 1 experienced rainfall suitable for *Abutilon* occurrence, but for two of these *Abutilon* was excluded by post-flooding competition (or for three of them in the case of the lower-lying site 4). *Hibiscus* growth was stimulated under drier conditions than was *Abutilon* germination, possibly because of its perennial rootstock.

In some desert species, falls of rain as low as 10 mm can produce germination[10]. While 26 mm was the minimum rainfall recorded here which produced seedling emergence of *Abutilon*, the actual quantity of rain needed will be greatly influenced by the high clay content of the study area, which has an unfavourable influence on water supply in this climate due to the inverse texture effect[11].

Plant species of arid and semi-arid areas are often grouped into 'summer flora', 'winter flora' or those that can germinate and establish in both seasons[12]. The species studied here are clear examples of summer flora. In our study area, *Sida trichopoda* (Malvaceae) behaves very much like *Hibiscus*. In north-western Victoria, probably all species of *Abutilon* and *Sida* are of the summer-growing type[13,14]. The taxa of *Abutilon* and *Hibiscus* studied here can occur in areas with less than 200 mm mean annual rainfall, much lower than the study area[15]. Further work is needed to explain why they do not extend further south; lower incidence of summer rain, lower temperature regimes (including frost effects) or both may be involved. A further important factor in *Abutilon* and *Hibiscus* occurrence is grazing, with cattle removal having beneficial effects at least on the *Hibiscus* population.

Abutilon is a transient species which can be absent from a site for at least six years before re-appearing. This behaviour almost certainly relies on hard-coated seeds forming a persistent soil seed bank as it does in *Abutilon theophrasti*[16]. Parsons & Browne[17] give examples of longer intervals before re-appearance.

Many transient species regenerate profusely during favourable circumstances. Their absence over years during dry seasons does not mean that they are threatened as long as seeds are produced often enough to ensure that germination occurs during favourable seasons. Many such species are not listed as either rare or threatened[18]. Nevertheless, more recent work points out that if the habitat is not continuously fit for occupation because of transient climatic conditions, this can increase extinction risk and so this factor is built into the new rules for classifying such risk[19].

While *Abutilon oxycarpum* is not threatened Australia-wide, there is concern about the Victorian stands, especially because they are widely disjunct from the species' core area and are at its southern limit. The most serious threat is grazing; while parts of site 1 and all of site 4 were fenced against stock in 1984, the fences are not kangaroo-proof and kangaroo grazing prevented seed set by most *Abutilon* plants in 1999 and some previous years. The fact that the maximum number of *Abutilon* plants recorded was well below 250 mature individuals in any one season means that the species qualifies as endangered in Victoria using the basic IUCN Red List rules for risk assessment[19]. The most important management recommendation following from our work is provision of kangaroo-proof fencing.

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[1] **Lang, P. J. & Kraehenbuehl, D. N.** (1990) pp. 179-185 *In* Noble, J. C., Joss, P. J. & Jones, G. K. (Eds) "The Mallee Lands, A Conservation Perspective" (CSIRO, Melbourne).

[2] **Parsons, R. F.** (1990) pp. 25-28 *In* Noble, J. C., Joss, P. J. & Jones, G. K. (Eds) "The Mallee Lands, A Conservation Perspective" (CSIRO, Melbourne).

[3] **Parsons, R. F. & Browne, J. H.** (1982) Biol. Conserv. **24**, 183-192.

[4] **Wheeler, J. R.** (1992) pp. 200-234 *In* Wheeler, J. R. (Ed.) "Flora of the Kimberley Region" (Western Australian Herbarium, Perth).

[5] **Cunningham, G. M., Mulham, W. E., Milthorpe, P. L. & Leigh, J. H.** (1981). "Plants of Western New South Wales" (NSW Government Printing Office, Sydney).

[6] **Jessop, J. P. & Toelken, H. R.** (1986) "Flora of South Australia" (South Australian Government Printing Division, Adelaide).

[7] **Fensham, R. J.** (1999) Rangeland J. **21**, 82-103.

[8] **Gullan, P. K., Cheal, D. C. & Walsh, N. G.** (1990) "Rare or Threatened Plants in Victoria" (Department of Conservation and Environment, Melbourne).

[9] **Clark, T. & Parsons, R. F.** (1994). Proc. R. Soc. Vict. **106**, 129-145.

[10]**Baskin, C. C. & Baskin, J. M.** (1998) "Seeds" (Academic Press, San Diego).
[11]**Parsons, R. F.** (1994) pp. 291-319 *In* Groves, R. H. (Ed.) "Australian Vegetation" 2nd Edn (Cambridge University Press, Cambridge).
[12]**Noble, I. R. & Crisp, M. D.** (1979/80) Israel J. Bot. **28**, 195-210.
[13]**Browne, J. H.** (1984) Vict. Nat. **101**, 228-233.
[14]**Browne, J. H.** (1986). *Ibid.* **103**, 150-157.
[15]**Brandle, R.** (1998) "A Biological Survey of the Stony Deserts, South Australia" (Department for Environment, Heritage and Aboriginal Affairs, Adelaide).
[16]**Briggs, J. D. & Leigh, J. H.** (1996) "Rare or Threatened Australian Plants" (CSIRO, Melbourne).
[17]**Keith, D. A.** (1998) Conserv. Biol. **12**, 1076-1090.

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